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ABSTRACT

College students enrolled in developmental mathematics and elementary algebra courses typically make the same mistakes repeatedly. Moreover, the same mistakes are made every semester, regardless of the students involved. Lev Vygotsky's concept of fossilization, which refers to the phenomenon of learning being lost over time and only behaviors remaining in learning, can help explain this phenomenon. "Academic fossilization" can occur in individuals when their connections to the skills and concepts learned in the past are lost over time. Students are left with the remnants of disconnected skills and concepts, leading to the possibility of those skills being used incorrectly. "Unfossilization" refers to the process of similar contexts and parallel concepts or processes being used to build new pathways to older knowledge. As the process unfolds, connections are made, new categories are created, new knowledge is added to the categories, and students develop a broader understanding of the relationships involved. Unfossilization differs from relearning in that relearning involves repeating the original process and retracing the same strands. One method of unfossilization is to present students with situations that are unfamiliar to them, causing them to pay attention to problems as presented. Another method of unfossilization is to present concepts through a task that learners have not performed previously. (Contains 5 references.) (MN)

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THE UNFOSSILIZATION OF CONCEPTS IN ADULT LEARNING

by

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C. M. Lerch

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The following discussion is a result of my reflection on the difficulties that college students face when enrolled in developmental mathematics and elementary algebra courses. The curriculum involved in these courses is not new to most of the students. Many have encountered the mathematics in elementary or high school. The content of such courses begins with simple arithmetic and progresses through the basics of algebra.

There are two levels of concern. The first concern is that regardless of how many times the students have encountered the content, they make the same mistakes over and over. The second concern is that the same mistakes are made every semester, regardless of the students involved. The students do not seem to be able to correct their mistakes, even though most recognize the errors when they are pointed out.

Upon research and reflection, I turned to one of Lev Vygotsky's (1978) constructs, fossilized learning, to help me understand what is happening in my classroom. Fossilization, in Vygotskian terms, is both cultural and historic in nature. The learning has been lost over time, only the behaviors remain. I propose that fossilization can occur in more than societal or cultural issues, as Vygotsky originally described. I maintain that "academic fossilization" can occur in the individual. In the case of academic fossilization, the connections to the skills and concepts learned in the past have been lost over time. The students are left with the remnants of disconnected skills and concepts, leading to the possibility of these skills being used incorrectly. Since this occurs in a learning environment, reversal of the process is possible. I propose that, through the process of

"unfossilization," adult students can build new pathways to the older knowledge through the use of parallel learning situations.

When teaching developmental mathematics and elementary algebra courses to college students, I have observed the same situations semester after semester, in multiple environments. Because the students have studied the material contained in these courses while in elementary school or high school, they do not pay careful attention to the material as it is presented. Typical comments include "I've had this before, I remember how to do this." Unfortunately, they are not checking their memory, just assuming it is correct. Consequently, they make the same mistakes over and over. The web of Figure 1 represents the lost connections that are present when fossilization has occurred (Albert, Bilics, Lerch, & Weaver, 1999).

> Schoenfeld (1987) identified this phenomenon when stating that one can make a fundamental error in assuming that the student who hasn't learned a topic yet simply 'hasn't learned it yet.' It may be the case that the student has indeed learned something – a consistent interpretation of the subject matter that just happens to be wrong. In that case our explanations of the right procedure, no matter how clever, may fall on deaf ears (p. 25).

What is even more puzzling is that the students are consistent in the mistakes that are made, again, no matter the background. Since the learning has been fossilized, the connections are no longer developed, and the students make the leap to an incorrect result.

Once academic fossilization has been identified, the process of unfossilization follows. I use the term "unfossilization" to mean the breaking of the old, incomplete

connections in order to make new connections. **Unfossilization** is the process of developing new strands on the learning web by using similar contexts, parallel concepts or processes (Lerch, 2000). New links to the fossilized end points are developed. Connections are made, and new categories are created. The old knowledge is reconnected, the new knowledge is added to the categories, and the students have a broader understanding of the relationships involved. Unfossilization is not the same as relearning since relearning involves repeating the original process, retracing the same strands.

I have identified two different situations where I have used the process of unfossilization. In the first, unfossilization may be accomplished by working on a task that does not appear related to the concept involved. The concepts are not made known to the learner at first. They are presented with a situation that is not familiar to them, causing the adult to pay attention to the problems as presented, a condition Baddeley (1990) identified as necessary for learning. The parallel nature of the learning tasks becomes evident after the concepts are understood. An example of a parallel learning situation is the development of place value through the use of different bases.

A second method of unfossilization would be to present the concepts through a task that the learners have not done before. In this situation, the concepts are evident from the beginning. The learner is presented with an alternative method to learn the required material. The example provided for this method of unfossilization is seen in the use of the Punnett squares for multiplying and factoring polynomials. The students who have adopted this method are successful with factoring.

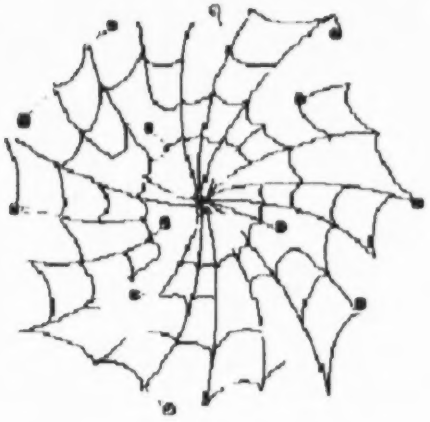

Figure 1. Fossilized Learning

Figure 2. Unfossilized Learning

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Issue

- Consistent errors
  - Corrections difficult
  - Same errors year after year
    - Different colleges, backgrounds, level of students

Background

- Multiple environments
- Repetitive material
  - Feel already know
- Examples
  1. Place value
     - Identify places
     - Relationship to operations
  2. Square expansion $(2x+3)^2 = 4x^2+9$

Vygotskian Constructs/Principles

- Tool & sign
  - Tool
    - Outward directed activity
    - Control environment
  - Sign
    - Inward directed activity
    - Mastering oneself
- Socio-cultural nature of learning
  - Bring old knowledge and learning
  - Perception connected to previous learning

Vygotskian Constructs/Principles

- Fossilized learning
  - Processes have died away
  - Actual process of learning has been lost
  - Don't know why do something
  - Example: roast beef

Academic Fossilization

- Connections to skills and concepts previously learned have been lost over time
- Remnants of disconnected skills and concepts

Learning as a Web

- Vertices represent concepts and skills acquired
- Strands represent other components of the learning process
- Interconnectedness of learning

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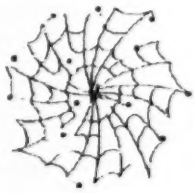
Academic Fossilization

- Struggle of the learning is forgotten
- Connections to prior learning situations lost
- Loosely connected bits of information
  - Used incorrectly
  - No longer tied to main body of knowledge

Academic Fossilization

- Vertices disconnected
  - Concepts tenuously connected to a bit of knowledge
  - Purpose is vaguely recalled
- Strands broken or missing
  - Loss of connections over time



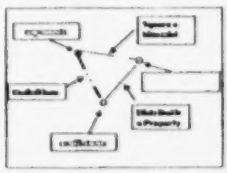
Academic Fossilization

$(2x+3)^2$

- Loosely connected bits
  - Physical similarity to distribution

$2(2x+3)$

- Confusion of definitions
  - Coefficient vs exponent
  - FOIL vs distribution



Academic Fossilization

Square a binomial	Distribution
$(2x+3)^2$	$2(2x+3)$
▫ Exponent	▫ Coefficient
▫ Repeated multiplication	▫ Repeated addition
$(2x+3)^2$	$2(2x+3)$
$(2x+3)(2x+3)$	$2\cdot 2x+2\cdot 3$
$4x^2+12x+9$	$4x+6$

Unfossilization

- Breaking of the old incomplete connections in order to make new connections
- Developing new strands on the learning web

Parallel Learning Situations

- Task does not appear related to original task
- Concepts not made known to learner at first
- Build new pathways by working in different context
- Parallel nature of learning becomes evident after concepts understood

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Parallel Learning Situations

Place value – work in different bases
Find the patterns

Units	Flats	Squares	Cubes
Single blocks 1s	4 10 1*base	4*4 10*10 Base^2	4*4*4 10*10*10 Base^3

Similar Contexts

- Present concepts through a task that is new to the learners
- Concepts are evident from the beginning
- Creation of a new tool

Similar Contexts

Punnett squares to multiply binomials

$$(3x-2)(2x+5)=6x^2+11x-10$$

	$3x$	-2
$2x$	$6x^2$	$-4x$
$+5$	$+15x$	-10

($+11x$)

Discussion & Implications

- Academic fossilization includes a return to a "default response"
  - Self-evident, automatic response
  - Confidence
  - Ignore warnings
- Won't easily change what feel already know
- Expend energy defending integrity of their knowledge

Discussion & Implications

- Result of TIMSS (3rd International Mathematics and Science Study)
  - Need to link concepts to prior learning
- Language is very important
  - Remove confusions
- Plan using parallel or similar situations

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